CLAIMS

1. An image display device which comprises an image display panel, in which two or more groups of particles having different colors and different charge characteristics are sealed between two substrates, at least one of two substrates being transparent, and, in which the particles, to which an electrostatic field produced by a pair of electrodes provided on respective substrates is applied, are made to fly and move so as to display an image, characterized in that micro-concave portions and/or micro-convex portions are provided to a part of or an overall of a surface of the electrode.

2. The image display device according to claim 1, wherein the micro-concave portions and/or the micro-convex portions are constructed in such a manner that the following formulas are satisfied:

average width/maximum average particle size > 2; and

average height/maximum average particle size > 2;

where a length across corner of a projection shape of the micro-concave portions and/or the micro-convex portions with respect to an electrode surface is assumed to be the average width, an average absolute value of a depth and/or a height of the micro-concave portions and the micro-convex portions is assumed to be the average height (depth), and a largest average particle size among the two or more groups of particles is assumed to be the maximum average particle size.

3. The image display device according to claim 2, wherein a plurality of the micro-concave portions and/or the micro-convex portions are provided to the same electrode and an average distance between the portions is constructed to satisfy the formula: average distance/maximum average particle size < 50.

4. The image display device according to claim 2 or 3, wherein an insulation layer is provided to a surface of the electrode and the micro-concave portions and/or the micro-convex portions are provided to the insulation layer.

5. The image display device according to one of claims 2 - 4,

wherein a gross area of the projection shapes of the micro-concave portions and/or the micro-convex portions on the electrode surface is 0.1 - 50 % with respect to an area of the electrode.

6. An image display device which comprises an image display panel, in which two or more groups of particles having different colors and different charge characteristics are sealed between two substrates, at least one of two substrates being transparent, and, in which the particles, to which an electrostatic field produced by a pair of electrodes provided on respective substrates is applied, are made to fly and move so as to display an image, characterized in that micro-cutout holes are provided to a part of or an overall of a surface of the electrode.

7. The image display device according to claim 6, wherein the micro-cutout holes are constructed in such a manner that the following formula is satisfied:

maximum width/maximum average particle size > 10;

where a largest length across corner of a shape of the micro-cutout holes is assumed to be the maximum width and a largest average particle size among the two or more groups of particles is assumed to be the maximum average particle size.

8. The image display device according to claim 6 or 7, wherein a plurality of the micro-cutout holes are provided to the same electrode and a minimum distance between the holes is constructed to satisfy the following formula:

minimum distance/maximum average particle size < 50.

9. The image display device according to one of claims 6 - 8, wherein a gross area of the micro-cutout holes is 0.1 - 50 % with respect to an area o the electrode.

10. The image display device according to one of claims 1 to 9, wherein an average particle diameter of the particles is 0.1 to 50 μm.

11. The image display device according to one of claims 1 - 10, wherein a surface charge density of the particles measured by a carrier and in accordance with a blow-off method is not less than 5 $\mu C/m^2$ and

not greater than 150 $\mu C/m^2$ in an absolute value.

12. The image display device according to one of claims 1 - 11, wherein the particles are particles in which the maximum surface potential, in the case that the surface of particles is charged by a generation of Corona discharge caused by applying a voltage of 8 KV to a Corona discharge device deployed at a distance of 1 mm from the surface, is 300 V or greater at 0.3 second after the Corona discharge.

13. The image display device according to one of claims 1 - 12, wherein a color of the particles is a white or a black.

14. An image display device in which particles are sealed between substrates, at least one of the substrates being transparent, and, in which the particles are moved so as to display an image, characterized in that a surface of the substrate to which the particles are contacted is coated thinly by an insulation member having a volume resistance of not less than 1×10^{12} [$\Omega\cdot$cm] so as to provide a thin insulation film.

15. The image display device according to claim 14, wherein a thickness of the thin insulation film is not more than 5 μm.

16. The image display device according to claim 14 or 15, wherein the insulation member to be coated on the substrate is the member in which the maximum surface potential, in the case that the surface of the insulation member is charged by a generation of Corona discharge caused by applying a voltage of 8 KV to a Corona discharge device deployed at a distance of 1 mm from the surface, is 300 V or greater at 0.3 second after the Corona discharge.

17. An image display device in which particles are sealed between substrates, at least one of the substrates being transparent, and, in which the particles are flown and moved so as to display an image, characterized in that an arithmetic average roughness (Ra) and a concave-convex average distance (Sm) of a surface of the substrate, to which the particles are contacted, satisfy the following formulas (1) and (2):

$$d(0.5)/10 \geq Ra \geq d(0.5)/200 \qquad (1)$$

$$d(0.5)/10 \geq Sm \geq d(0.5)/1000 \qquad (2)$$

(here, d(0.5) means a value of the particle size expressed by μm wherein an amount of the particles having the particle size larger than this value is 50%).

18. The image display device according to claim 17, wherein the value of d(0.5) is 0.1 - 50 μm.

19. The image display device according to one of claims 14 - 18, wherein a space in the device is filled with a gas having a relative humidity at 25°C of not more than 60% RH.

20. The image display device according to one of claims 14 - 19, wherein a particle size distribution Span of the particle, which is defined by the following formula, is less than 5:

$$Span = (d(0.9) - d(0.1))/d(0.5) ;$$

(here, d(0.5) means a value of the particle size expressed by μm wherein an amount of the particles having the particle size larger than or smaller than this value is 50%, d(0.1) means a value of the particle size expressed by μm wherein an amount of the particles having the particle size smaller than this value is 10%, and d(0.9) means a value of the particle size expressed by μm wherein an amount of the particles having the particle size smaller than this value is 90%).

21. The image display device according to one of claims 14 - 20, wherein a solvent insoluble rate of the particles, which is defined by the following formula, is not less than 50%:

$$\text{solvent insoluble rate (\%)} = (B/A) \times 100;$$

(here, A is a weight of the particle before being immersed into the solvent and B is a weight of particles after the particles are immersed into good solvent at 25°C for 24 hours).

22. The image display device according to one of claims 14 - 21, wherein the image display device is formed by a plurality of display cells defined by partition walls.

23. The image display device according to claim 22, wherein the partition walls is formed by one of a screen-printing method, a sand-blast method, a photo-conductor paste method and an additive method.

24. The image display device according to claim 22, wherein the partition walls have a cantilever structure.

25. An image display device which comprises an image display panel, in which two or more groups of particles having different colors and different charge characteristics are sealed between two substrates, at least one of two substrates being transparent, and, in which the particles, to which an electrostatic field produced by a pair of electrodes provided on respective substrates is applied, are made to fly and move so as to display an image, characterized in that an image display state is read-out by detecting a fly/move current produced when the particles are flown and moved in a pixel.

26. The image display device according to claim 25, wherein the image display state read-out step is performed in such a manner that overall black color image writing or overall white color image writing is performed with respect to the displayed image and a display density of respective pixels is obtained from an integral value of the fly/move current flowing through respective pixels when the image writing step is performed.

27. The image display device according to claim 25 or 26, further comprising a fly/move current detecting portion for detecting the fly/move current and an integrator for integrating the fly/move current.

28. The image display device according to one of claims 25 - 27, wherein the fly/move current is detected by utilizing the electrodes used when the image writing step is performed.

29. The image display device according to one of claims 25 - 28, wherein an image re-writing step is performed on the basis of the read-out image display state.

30. The image display device according to one of claims 25 - 29, wherein an average particle diameter of the particles is 0.1 - 50 μm.

31. The image display device according to one of claims 25 - 30, wherein a surface charge density of the particles measured by a carrier and in accordance with a blow-off method is not less than 5 $\mu C/m^2$ and

not greater than 150 $\mu C/m^2$ in an absolute value.

32. The image display device according to one of claims 25 - 31, wherein the particles are particles in which the maximum surface potential, in the case that the surface of particles is charged by a generation of Corona discharge caused by applying a voltage of 8 KV to a Corona discharge device deployed at a distance of 1 mm from the surface, is 300 V or greater at 0.3 second after the discharge.

33. The image display device according to one of claims 25 - 32, wherein a color of the particles is a white or a black.

34. The image display device according to one of claims 25 - 33, wherein the image display panel comprises a matrix electrode having a plurality of scan electrodes and data electrodes arranged substantially parallel thereto.